2012

Materials of Living Origin - Educational Uses

A Code of Practice for Scottish Schools and Colleges

Contents

Preface
This third edition of the Code of Practice (2012) has been drawn up by SSERC to take into account changes in legislation and teaching practice since the publication of the second edition (2005).

The Code of Practice was originally drawn up by a Working Group of practitioners convened by the Department of Education of what was at that time Strathclyde Regional Council.

We have tried hard to stick to the principles behind, and the generally positive educational spirit of, the original version of this code. Many of its provisions serve merely to recognise and confirm elements of good practice. Those provisions should therefore offer little or no surprise to the experienced and thoughtful practitioner.

Nonetheless, there are matters here where there can be much uncertainty, not the least because of varied and conflicting advice. Particular concerns have been raised, sometimes unnecessarily, because of health and safety considerations. Some of these concerns may be justified. Others are much less so, especially when they apparently fly in the face of the available evidence. Therefore, one of the purposes of this code is to offer teachers, technicians and others clear guidance on what is currently acceptable educationally in the use of living organisms and materials of living origin.

Space precludes the provision of a lot of detailed information, which, in any case, might simply obscure the main points of principle. Readers are instead referred for such detail to the various sources indicated in some of the footnotes or to the excellent references listed at the end of this publication. SSERC will also continue to provide updates on relevant detailed information through its Bulletins and the members' section of the SSERC website.

Review
We intend keeping this code under review. Educational and biological circumstances change. We would not like to see this guidance become so dated as to be less than useful in practice. Teachers, technicians and others are thus encouraged to submit views and information relevant to the code and its practical application via sts@sserc.org.co.uk.

Acknowledgements
We acknowledge the contributions of the members of the original Working Group whose insight and commitment to meaningful educational work with living organisms and materials of living origin resulted in the Code of Practice for teachers. It is a testament to their common sense and practicable approach that much of the Code of Practice continues to meet the requirements of current health and safety legislation and educational practice. The contribution of Jim Stafford who chaired the original Strathclyde Working Group and who led the review that produced this current edition is gratefully acknowledged.

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Introduction

Layout and scope

This third edition of the Code of Practice on the educational uses of living materials, and those of living origin, broadly follows the same layout and adopts a similar approach to that of the original. Each section of the code begins with an educational rationale. This is because of our conviction that for any educational application of living materials to be justifiable, it has to bring with it real and positive educational benefits. We have also taken the opportunity, where appropriate, to indicate the social relevance of certain types of activity. This may involve issues such as the need for education about risks or on ethical and other social dimensions to the science. Thus opportunities arise to develop aspects of responsible citizenship and to make effective contributions to related issues in society. Following on from the educational rationale for each section comes a set of simple, practical statements indicating widely-accepted good practice in the sub-set of educational applications described.

General principles

The use of material of living origin in schools can considerably enhance children and young people's educational experience. It may allow:

- the opportunity to develop respect, care and responsibility for living things;
- first hand experience of living material to develop knowledge, understanding and enquiry skills;
- educational experiences that are interesting and stimulating;
- an appreciation of relative risks and of controlling risks - whether to the individual or to society more generally.

In producing this Code of Practice every effort has been made to enable teachers to provide, with confidence, the most meaningful educational experiences possible while taking into account the considerations below:

- ensuring that the use of the material can be justified educationally;
- source of material;
- using the minimum of materials or organisms to attain the educational objectives;
- the conservation of living materials and not only those protected by law;
- the care and welfare of any animals kept in schools and the legislation on animal welfare;
- the sensitivities of pupils, other staff, parents and the wider community;
- health and safety legislation;
- the experience of staff;
- the facilities available in the schools;
- the proper and safe disposal of any materials used.

Updates

This document is available in electronic format on, and available for download from, the SSERC website: www.sserc.org.uk. Any updates to the guidance will be posted on the site and notification thereof given in SSERC newsletters and/or Bulletins.

Pupils as Subjects of Experiment or Investigation

1

Principles

Pupils should be encouraged, but never feel under any pressure, to participate as subjects of experiment or investigation.

In addition to any conventional educational value, acquiring knowledge about themselves is of inherent interest to many learners.

Any such demonstrations and investigations should observe the sensitivity of learners at all times. In so doing learners have the opportunity to develop respect for others and participate responsibly in scientific investigations.

Specific advice

1.1 There should be no pressure on learners to perform or take part in any experiment or activity that involves significant physical exertion or making body measurements on themselves.

1.2 Sensitivity should be applied in the use of results. Measurements should not normally be attributed to named pupils.

1.3 Investigations into patterns of heredity should be treated sensitively by teachers. Teaching should not normally relate directly to pupils' own heredity (see also Section 6 on DNA). Pupils should usually refer to third party examples in texts or other resources.

1.4 Learning and teaching opportunities where pupils or students may volunteer medical or biologically relevant information about their own family history should be treated sensitively by teachers to avoid distress or inappropriate disclosure by pupils.

1.5 Choice of physical exercise should be sufficient to demonstrate physiological effects without being excessive. It is necessary to avoid competition between pupils when exercising for such purposes.

1.6 Information should be obtained on any relevant medical condition of pupils (e.g. asthma) before proceeding with activities based on exercise.

1.7 Substances to be tasted should be freshly prepared from material kept exclusively for that purpose under normal domestic hygiene conditions. It should be made absolutely clear that this is a departure from the normal rule that nothing is to be ingested in a laboratory. If practicable, try to set up such tasting activities in a home economics or communal dining facility.

1.8 Cheek cells may be sampled using the procedure in Appendix 1.

1.9 Human body fluids:
- saliva may be used so long as the procedure in Appendix 2A is followed;
- sampling of human blood requires approval from the employing authority. Appendix 2B provides advice on seeking such approval and acceptable procedures;
- other fluids which post-16 students may wish to use in investigative work include urine (see Appendix 2C) and sweat. Such use is permissible if the necessary steps are taken to minimise any risks of infection. [1]

1.10 Only apparatus designed for medical educational or personal use should be used for physiological measurements. Pupils and teachers should be aware of the inherent limitations of any such apparatus. The use of such apparatus for physiological measurement should always be educational and never diagnostic.

1.11 The mouthpieces of all such equipment must be disinfected or sterilised before and after each use. The disinfectant must always be freshly prepared prior to use and must be active against viruses e.g. chlorine- based such as a diluted bleach solution or *Virkon* (rinsed off before use). Disposable mouthpieces may also be used.

[1] SSERC can provide further, specific advice on suitable procedures.

2 Keeping Animals in School

Principles

Living things make an important contribution to the education of children and young people. Keeping animals can create an awareness of their needs and a sensitivity towards them, leading to a concern and respect for all living things. In the classroom, animals become a focus of interest and can provide an opportunity for scientific investigation. Before keeping any animal in school, staff should: consider all the substitutes; be sure that the species' survival is not endangered and be convinced that keeping a particular animal is the best way of achieving the stated educational objectives. It is important also not to fall into the trap of equating "animals" only with vertebrates and to emphasise the need to treat all living things with appropriate respect.

An animal's well-being should always be of paramount importance if that animal is kept in school. As one alternative to keeping animals in school, wild animals, e.g. many species of birds, could be encouraged into the school grounds. There they may be observed in their natural habitat. Another possibility is to use some of the specialist peripatetic services now available, whereby living specimens are brought into school on a temporary basis and specialists talk to pupils about the biology of such animals, their needs and how to care for them.

The key consideration is that there should always be sound educational reasons for having any animal in school. By applying these principles to animals in schools learners have the opportunity to make links to the principles of refinement, reduction and replacement (the three Rs [2]) that are applied in licensed animal research. As citizens this allows learners to develop informed ethical views of scientific issues based on first hand experience of animal welfare.

Prerequisites

2.1 A member of staff must have an understanding of the biology and natural history of the animal and thus be able to cater for its needs and so ensure its wellbeing.

2.2 Appropriate care must be provided, or arranged for, during the week, weekends and school holidays. A written, operational policy outlining maintenance and procedures for the care of animals should be available. Its existence should be made known to the relevant staff.

2.3 If animals are to be taken home, the procedures exemplified in Appendix 3 should be adopted.

2.4 Suitable accommodation for the animals must be provided. Animal accommodation must be positioned in such a way that pupils, especially very young children, cannot be scratched or bitten.

2.5 Arrangements should be made for any professional veterinary care that may be required.

2.6 The numbers and range of animals in the school should be the minimum required by the educational objectives of keeping them. Mammals should normally be kept singly or in non-breeding pairs.

2.7 Consideration should be given to the possibility of allergic reactions in pupils or staff to the fur or skin scales of animals.

Types of animals

2.8 For more guidance and examples of vertebrates and invertebrates which are suitable to be kept in schools see Appendix 4.

2.9 Do not keep any animals in school for which there is insufficient time, money, expertise or commitment to ensure their well-being.

2.10 Some imported, exotic, species, whether vertebrate or invertebrate, have been known to present specific hazards of infection to humans (zoonoses or zoonotic infections). These are rare and generally only apply to imported animals such as some reptiles (such as terrapins and tortoises) and molluscs such

[2] Refinement is about improving animal welfare and reducing any potential pain or distress. Improving housing, care and enriching their environment means animals live better lives with less stress. Reduction means reducing the number of animals to the minimum required to achieve an objective. Replacement means using non-animal techniques wherever possible to achieve the same aim.

as the Giant African Land Snail (*Achatina fulica* and related species). There are also sound ethical reasons why schools would wish to avoid some imported species as they may have been collected from the wild. Specimens bred and raised in captivity in the UK offer little if any risk to human health so long as simple precautions are taken to ensure sound hygiene.

2.11 Birds should not normally be kept in schools. Some suppliers and organisations offer fertile hens' eggs to be hatched in schools. This requires specialist equipment and expertise and should not normally be attempted in schools. SSERC can provide specialist advice on this if required.

2.12 If reptiles are kept, then particular care has to be taken to select suitable species and especially to ensure that their dietary and other needs can be met.

2.13 A wide variety of invertebrates are suitable to be kept in schools. Care should be taken to ensure that any species chosen does not present a health hazard or an infestation hazard should they escape.

2.14 Animals protected by law must not be kept in schools.

Sources of animals

2.15 If animals are to be purchased, reputable breeders or licensed suppliers are to be used. Such animals must not be released into the wild. Animals are not to be accepted by a school as casual gifts, nor should animals in a school be gifted to others or sold.

2.16 Certain animals (e.g. woodlice, earthworms, garden snails, slugs and freshwater invertebrates) may be collected from the wild and maintained in the school for short periods. Thereafter they should be returned to their normal habitat after use.

2.17 External agencies, such as zoological gardens or other specialist services, which provide a service bringing animals into schools should have the permission of the education authority (or in the independent sector the school governors) to provide the service.

2.18 Small mammals, suitable for use in schools, may be brought to school on a temporary basis - for educational purposes. Appropriate arrangements must be made for the transport of the animals and for their care while in school. No animal so brought to the school should be in contact with other laboratory animals in order to minimise the likelihood of transmission of disease.

2.19 Pupils should not bring sick or 'lost' animals into school.

Care of animals

2.20 Animals must be well-maintained and afforded appropriate housing, feeding and bedding. Relevant literature should be consulted. Cages and vivaria should be secure against the escape of animals or the entry of wild animals.

2.21 Animal accommodation must meet the animal's need to exhibit normal behaviour patterns.

2.22 All shelving, cages and water bottles must be thoroughly cleaned on a regular rota basis with hot water and a suitable combined surface-active disinfectant and detergent.

2.23 All food materials should be stored in closed containers (and not in disproportionate bulk) to minimise the risk of infestation.

2.24 Due care should be exercised in the setting up of any electrical installations for aquaria.

2.25 Hands should be thoroughly washed immediately before and after handling any living organism, after cleaning cages, vivaria or aquaria, and before handling animal food. If animals are allowed on work surfaces the surfaces must afterward be disinfected with a suitable combined surface-active disinfectant and detergent.

2.26 Where there is a significant risk of a bite or a scratch, suitable gloves must be worn.

2.27 If a bite or a scratch is inflicted, but there is no broken skin, the area should be thoroughly washed. If the skin is broken the school first aider should be consulted and then, if necessary, medical attention should be sought.

2.28 All animals should be inspected at regular intervals for signs of distress, disease and ill health.

2.29 Sick animals must be quarantined. If serious disease is suspected, veterinary advice should be sought.

2.30 Faecal matter, soiled litter, dead animals and other remains of living organisms must be disposed of double bagged in opaque polythene through an appropriate disposal system (Appendix 6).

2.31 Mammals and other vertebrates must not be sold, gifted or awarded as prizes to pupils.

Use of animals

2.32 Animals may be kept so that the pupils gain knowledge and experience of the behaviour, needs and demands of a particular species and how to meet such requirements.

2.33 Animals must be treated humanely and with sensitivity to their needs at all times.

2.34 Under no circumstances should vertebrate animals be subjected to an experiment or procedure liable to cause pain or inordinate stress.

2.35 Regardless of any strict legal requirement, invertebrates also must be seen by pupils to be treated with appropriate sensitivity.

2.36 The over-riding requirement is that of good husbandry. This means that there should be no significant interference with, nor departure from, routine procedures intended to ensure any animal's normal condition of wellbeing.

2.37 Animal behaviour investigations where small mammals negotiate mazes or similar apparatus to find a food reward require particular care. The potential for distress can be reduced (the refinement of the three Rs) by using animals that are used to regular considerate handling and by using desirable foods as rewards rather than removing food prior to the investigation to motivate animals.

Surveying & Collecting Living Materials from the Environment for Investigation 3

Principles

Most wild animals and plants are best observed in their natural habitat or in reputable wildlife reserves or maintained collections such as botanic gardens. Fieldwork is a valuable part of the biological curriculum. Its inherent interest for many young people can make it a powerful motivating influence. It can encourage an appreciation of living things and help develop an understanding of the relationships between living things and their environment. It can illustrate the practical need for conservation and thus contribute to their development as responsible citizens and effective contributors to environmental concerns.

Specific advice

3.1 All animals taken from their natural environment for study should be returned as soon as possible. Care should be taken to remove any protected species from a sample in which they have been inadvertently collected. Collection and sampling should be kept to the minimum needed to achieve the educational objectives of the activity.

3.2 If mammal traps, including Longworth types, are used to study small animals, the procedures detailed in Appendix 5 must be adopted.

3.3 Fully protected animals, both vertebrate and invertebrate [3], must not be killed, injured or taken or have their habitat damaged. This restriction includes ecological studies using capture, mark, release and recapture techniques.

3.4 The value in observing amphibian development is clearly recognised but some species of native amphibians, including their spawn and tadpoles, are protected [3]. Spawn or tadpoles of these protected species must not be brought back to school [4]. Where spawn of currently non-protected species, such as of the 'Common' Frog or Toad is collected only small amounts should be taken for study. Suitable conditions for the tadpoles to grow and mature should be provided and they should be returned to a suitable environment, preferably the one from which they were taken. It is difficult always to identify with confidence the spawn and tadpoles of protected species. Where it is a practical option, then development may be best studied by a series of visits to the habitat.

3.5 No native, wild birds or mammals living or dead (including road kill), may be brought into school. Birds' eggs must not be collected. Birds' nests must not be damaged or destroyed whilst being built or in use.

3.6 Pupils should be reminded not to bring sick or 'lost' animals into school. Nonetheless, there should be a contingency plan, one known to relevant staff, should they 'forget' and do so.

3.7 Protected plants [3] must not be picked, uprooted or destroyed. Parts of other plants, growing in the wild, e.g. leaves and flowers, may be picked but they must not be uprooted without the permission of the landowner.

3.8 Activities involving skin contact with plants must take into account the possibility of allergic reaction. Species which are most likely to trigger such responses should be avoided (see reference section).

3.9 Pupils should be reminded, as necessary, that many seeds, fruits and other parts of plants are poisonous if eaten. The default position is to assume that a plant part is toxic or harmful unless one knows for certain that it is safely edible.

[3] Protected species - there are three pieces of legislation that list the names of species that are protected and some that are protected by *"special penalties"*. The names of the species protected are listed in: Schedules 1-8 of the *Wildlife & Countryside Act 1981*; Schedules 2, 3 and 4 of *The Conservation of Habitats and Species Regulations 2010* and in *The Protection of Badgers Act 1992* which only offers protection for the badger and its sett. Contents of the schedules can be accessed at the "Protecting Scotland's Nature: Protected Species" section of the SNH website. Information on the documents themselves is available from the HMSO website.

[4] Effectively, at present, of Natterjack Toads (which have a restricted range in Scotland) and of Great Crested Newts. See www.snh.gov.uk/about-scotlands-nature/species/amphibians-and-reptiles/amphibians/

3

3.10 The site and activities involved in environmental sampling must be chosen carefully. It is wise to plan any visit and take into account the possibility of contamination. Public spaces may be subject to cat and dog fouling, sewage or rat urine and consequent infection e.g. Toxocara and Weil's disease (Leptospirosis). Farm animal faeces can also be a potential source of pathogens such as *Salmonella* and *E. coli* (including *E. coli* 0157). Normal practices of good hygiene (covering any cuts or grazes, hand washing afterwards etc.) should be adopted and protective clothing such as gloves used where appropriate [5].

3.11 Composted (well rotted) animal manure is likely to have a reduced or negligible level of pathogen contamination and may be used as a soil conditioner in school garden projects. Normal good hygiene practices including a change of clothing/protective clothing and footwear should be used. Consideration should be given to using alternative and potentially less hazardous materials. Samples from manure must not be used for microbiological culture.

3.12 Any site used for fieldwork should be subjected to minimum disruption. Any stones and rocks overturned, or otherwise disturbed, should be replaced. Heavy trampling should be avoided.

[5] Advice on school visits to farms is provided by the Royal Highland Educational Trust (www.rhet.org.uk/teacher/farm+visits), the Health and Safety Executive (www.hse.gov.uk/pubns/ais23.pdf) and the Scottish Government (www.scotland.gov.uk/library5/health/ecsip-00.asp).

Use of Animal Material for Dissection or Experimentation

4

Principles

The use of animal material in school can be of considerable educational value and a range of material is available and suitable for this purpose. In so using animal material, care should be exercised regarding the sensitivity of pupils to the use of such material.

Pupils should understand the educational objectives of using the material and be aware of the consequences of the use of the material to the species involved and of its impact on the environment.

This is also an area where there are currently well-publicised, rather than necessarily well-understood, hazards. In a number of cases these dangers are theoretical rather than significant in terms of the actual, practical risks. It is in assessing the risks and taking informed decisions to control any risks and in explaining these clearly to learners that much of the real educational value lies in developing confident individuals.

Specific advice

4.1 No pupils should be required to take part in or observe any dissection procedure if they do not wish to do so.

4.2 Where appropriate, the use of scissors rather than of surgical scalpels will reduce the incidence of accidental cuts.

4.3 Disposable gloves are not usually necessary at this level and they may impair dexterity thus increasing the chances of cuts etc. Nonetheless, they should be available to those pupils who wish to use them.

4.4 Exposed cuts or grazes should be covered with waterproof dressings before handling any animal material. Hands must be washed thoroughly afterwards.

4.5 Only materials fit for human consumption obtained from abattoirs, butchers or fishmongers may be used for the purpose of dissection or experimentation. For advice on the use of nervous tissue (including eyes) from cattle and sheep see Appendix 7. All such materials must be used while they are still fit for human consumption - in addition, see 4.10.

4.6 Skeletal material (bones, teeth etc.) may be used for demonstration and for investigative work. If fresh material is used it may be necessary to disinfect or autoclave the material as a result of a risk assessment to sterilise any remnants of once living tissue. Such treatments may change the properties of the material somewhat. That will have to be borne in mind when planning any investigation.

4.7 If acid treatment is used to demonstrate or investigate the composition of bones and teeth, vessels should be loosely plugged to contain any aerosol that forms as the carbon dioxide gas is evolved.

4.8 Where animal blood is used, whether from an abattoir or other source related to food production, a risk assessment of the specific procedure must be carried out. Blood must only be centrifuged in capped, plastic tubes.

4.9 For some biochemical purposes (e.g. spectrometry), blood may be simulated with an aqueous solution of haemoglobin.

4.10 Preserved vertebrate specimens may be purchased for the purpose of dissection where relevant in post-16 courses.

4.11 Live invertebrates may be purchased for the purpose of dissection or experimentation (but see Section 2).

4.12 Whole organism dissection of mammals and birds is largely unnecessary for Scottish school-based courses.

4.13 In any practical work with living, fertilised, birds' eggs, embryos must not be exposed beyond the halfway stage of incubation [6]. Appropriate visual aids may be used as substitutes.

4.14 Instruments used for animal material must be cleaned using hot water and detergent. Avoid the use of disinfectants, such as those based on chlorine, or *Virkon*, which can corrode instruments. Autoclaving before re-use is the preferred method.

4.15 Used animal material should be disposed of via an appropriate disposal route (See Appendix 6).

[6] SSERC can provide specialist advice on keeping fertile hens' eggs in schools if required.

5 Use of Plant Material

Plant science makes significant and critical contributions to socio-economic and global needs. Plants and plant products are key sustainable sources of food and materials for life in the 21st century. Appreciation of these factors is a key part of becoming a responsible and global citizen.

The need for individuals with appropriate knowledge of plant science - whether for professional, political or recreational purposes - is now probably greater than ever it has been in the past.

The growing of plants and their study in the environment can thus have considerable educational value. Plants also provide a rich variety of materials for practical and investigatory work. As well as their educational value growing plants and associated experimental work can provide much aesthetic enjoyment to pupils.

5.1 Hands should be washed after any classroom activity that involves handling plant material.

5.2 Suitable risk-control measures must be adopted when using plant material known to be poisonous, allergenic or chemically treated (e.g. seed dressings). Such control measures must be communicated to staff and pupils.

5.3 Any pesticides or herbicides used in schools must only be those designed and licensed for amateur use. Pupils should not routinely apply such preparations to plants. The instructions on manufacturer's or supplier's labels must be followed closely. Pesticides and herbicides must be stored in a secure and safe place (e.g. the chemical store).

5.4 A risk assessment of any specific procedure involving use of pesticides, herbicides, plant growth substances, fertilisers and growing media should be carried out and any significant findings recorded and conveyed to others who need them.

5.5 Care must also be exercised when working outdoors, and in handling plant material from the general environment, since contamination with pesticides or herbicides is always a possibility. A number of plants, both cultivated and growing wild, or specific parts of them are poisonous or allergenic. Such risks as are presented in wildlife gardens or similar areas are amenable to sensible controls through adequate supervision of learner activities.

5.6 Composted (well rotted) animal manure may be used as a soil conditioner when growing plants in school gardens or allotments as long as the conditions in 3.11 are applied.

5.7 Allergies to certain nuts, particularly peanuts, have become a significant problem for school science. Substitutes [7] are to be used in practical activities such as those on investigating the energy content of foodstuffs.

[7] See SSERC Bulletin 209 and references 1 and 3 in the selected bibliography.

6 DNA Technology

Practical work with DNA is valuable in developing and reinforcing theoretical understanding of the basic 'stuff of life'. It can also stimulate an interest in modern technological applications of biology and the impact of DNA technology on personal genetic information and personalised medicine. Such practical work also raises and encourages discussion of a number of highly significant, contemporary ethical and social issues. By relating their first hand experiences of working with DNA to real life situations, including the regulations on the use of genetically modified organisms [8], learners will have the opportunity to evaluate scientific issues and develop informed views as part of becoming a responsible citizen.

6.1 The extraction of 'DNA' [9] from various kinds of plant material (e.g. kiwi fruit, onion, peas and strawberries) is now a routine practical activity in many schools. It offers no significant or specific biological risks. It does however require care in storing, chilling and handling the highly flammable alcohol solvent used in the latter part of the extraction procedure.

6.2 The extraction of DNA from some soft animal tissues such as fish eggs (roe) is also acceptable. Calf thymus tissue (referred to in a number of texts and on the internet) should not be used (see Appendix 7).

6.3 DNA extracted from cheek cells can be used so long as one of the approved sampling procedures is followed (see Appendix 1).

6.4 A number of published DNA extraction methods intended for educational application require the use of phenol. This is no longer necessary and should be avoided since safer alternatives are now available (e.g. resin filters for extracting plasmid DNA).

6.5 DNA is also available from molecular biology and school suppliers. In general these sources and their associated protocols can be regarded as safe [10]. Full length viral DNA that may have been genetically modified and mammalian DNA that has not been screened to ensure it is free from contaminating viruses must not be used. Sources such as bacteriophage lambda, salmon sperm and cloned human DNA can generally be regarded as safe.

6.6 DNA may be amplified using PCR techniques. If using human DNA it is wise to avoid the use of human markers, especially where these may be indicative of a genetic condition (see also paragraphs 1.3 and 1.4).

6.7 The majority of practical DNA gel electrophoresis equipment and procedures such as those developed by SAPS and the NCBE or those available from commercial suppliers present minimal risk when used in accordance with the instructions. Appropriate risk assessments should always be carried out, however, particularly when using imported equipment or procedures or deploying home-made apparatus [11].

6.8 In general, genetic modification is outwith the scope of practical work in schools. However certain 'transformation' protocols known as 'self cloning' may be carried out in schools. Microbial transformation where DNA (or RNA) is returned to a species in which it could occur naturally is known as self cloning. Thus experiments in which plasmids are transferred from one strain of bacteria to another strain of the same species are not included in the regulations [8] and can be carried out in schools.

[8] Work with DNA is controlled by the *Genetically Modified Organisms (Contained Use) Regulations, 2000*. Much of the DNA work in schools falls outwith these regulations and the risks can be controlled by the normal processes of risk assessment.
[9] Much of the 'DNA' extracted from kiwi fruit and strawberries is in fact pectin.
[10] It is safest to use UK and European Union based suppliers as these are likely to comply with the relevant legislation. Sources in the USA and on the Web, as well as their associated protocols, may not comply with the more strictly regulated UK and European legislation.
[11] For more detailed information see reference 1 in the selected bibliography.

6

6.9 The pGLO plasmid which contains the Green Fluorescent Protein gene originally isolated from the bioluminescent jellyfish *Aequorea victoria* may be used in transformation protocols with *E. coli* strain HB101 K-12 in schools. This particular protocol is exempt from the contained use regulations although still subject to the Genetically Modified Organisms (deliberate release) Regulations, hence 6.10 below.

6.10 Transformed bacteria must be destroyed by autoclaving within one week of completing the experimental work.

6.11 Teachers wishing to extend practical work beyond the scope of these protocols would need to seek competent advice before proceeding. They should check with their Education Authority, or other employer, on any need to submit a specific risk assessment for approval. NCBE, SSERC and SAPS may be able to assist in this process.

7 Microbiology

Practical work in microbiology provides opportunities to develop understanding, practical skills and scientific investigations. Microbiological processes are widely used in industry and medicine. As such they demonstrate the economic and social significance of biology and its potential as an area of employment.

A number of topical issues and public concerns are relevant to this subject. Self awareness and decision making on a number of health and lifestyle matters related to being a confident individual is better informed when under-pinned by even a basic knowledge of microbiology.

As with work in a number of other sections of this present Code of Practice, microbiological practical activities bring their own hazards. The risks however are amenable to control. It is in taking the necessary steps to control any risk that learners will acquire at first hand the experience of assessing risks and taking informed decisions that is part of becoming a confident individual and a responsible citizen.

7.1 The guidance in the related Code of Practice "Safety in Microbiology: A Code of Practice for Scottish Schools and Colleges" must be adhered to [12].

7.2 Each establishment carrying out microbiological work, as described in the Code of Practice, should have at least one member of staff trained to Level 3 as detailed in the "Safety in Microbiology" Code of Practice.

7.3 In addition to the "Safety in Microbiology" Code of Practice, reference should be made as required, to the Microbiology Techniques Cards and the interactive versions published on the SSERC website. Reference may also be required to Topic 15 of Topics in Safety (3rd edition ASE 2001).

[12] The original version of that microbiology publication was prepared under the auspices of the Education Department of what was Strathclyde Regional Council. Subsequent editions have been prepared by SSERC.

8 Appendices

APPENDIX 1

Cheek cell sampling procedure

Adapted from a protocol first published by the Institute of Biology, this procedure is also endorsed by ASE, CLEAPSS and SSERC.

1) Pupils must only work with their own cheek cells.

2) Rinse mouth with water using disposable cup.

3) Take a cotton bud from a newly opened pack.

4) Move the cotton bud over the inside of the cheek on one side of the mouth and along the outer lower side of the gum.

5) Smear the cotton bud over a small area of a clean microscope slide.

6) Place the used cotton bud immediately in a small volume of freshly prepared chlorine based disinfectant or prepared chlorine based disinfectant or *Virkon*.

7) Place 3 drops of iodine solution (or alternative stain) from a dropper pipette onto the smear and cover with a cover slip.

8) After the cells have been observed, immerse the slide and cover slip in a beaker of freshly prepared chlorine based disinfectant or *Virkon*.

9) The teacher or laboratory technician should place the used (disinfected) cotton buds in a polythene bag. The bag should be sealed and then disposed of into normal refuse.

10) The disinfected slides and cover slips should be washed thoroughly and dried before re-use.

11) This basic procedure may also be adapted and used to take samples for simple investigations from the surfaces of teeth.

Related sampling procedures for DNA

1) The above procedure may also be adapted to take samples for DNA extraction for educational use. Students must work only with their own DNA samples which must not be used nor retained other than by the student themselves. Where such samples are amplified by PCR and analysed, then due regard must be paid to the sensitive issues this may raise (e.g. the nature of the information obtained, who sees it and the use, if any, to which it may be put). See Section 1 of this Code.

2) Liquid based extraction procedures, such as that used in the mtDNA protocol, may also be used. This involves washing a sterile solution around the mouth for 1 minute. This is a less intrusive and possibly safer procedure than the use of a cotton bud or sampling brush.

APPENDIX 2

Sampling human body fluids

A) Saliva sampling procedure

1) Pupils must only work with their own saliva and rinse their own equipment.

2) Rinse mouth with water using disposable cup.

3) Hold a sip of water in the mouth for a few moments.

4) Collect the water and saliva in a clean boiling test-tube or disposable cup and proceed with the experiment.

5) At the end of the experiment, test-tubes are rinsed out and immersed in a basin of freshly prepared chlorine based disinfectant or *Virkon*.

6) Test-tubes should be washed thoroughly and dried before re-use.

7) Disposable cups are placed in a polythene bag. The bag should be sealed and then disposed of into normal refuse.

B) Blood sampling

Guidance from UK Government Departments does not rule out the taking of human blood samples in schools and colleges. Although blood sampling is not encouraged it is for the employer to give approval.

For such approval to be granted, a teacher must be able to justify the procedure on educational grounds and demonstrate that they can ensure safety at all times. When human blood is handled there is a slight risk that viruses (or bacteria) may be transmitted. The most significant of these are HIV and Hepatitis viruses B and C. There is no significant risk of transmission of blood borne viruses if the correct sterile procedure is used. Safety here is heavily dependent on administrative controls (with pupils all following each instruction to the letter) and employers may remain reluctant to grant approval. Lancets or other finger pricking devices must be disposed of in a sharps disposal box. Local councils can collect and dispose of sharps boxes. Other waste is not regarded as clinical waste and can be disposed of through the normal refuse system [13]. SSERC can provide advice on suitable protocols for schools.

C) Urine

The sampling, analysis and use of human urine for educational applications is not routine at school level but school students in some post 16 courses have safely carried out investigations on this topic.

Such investigations have involved specific risk assessments and appropriate supervision. Much of the educational value of such investigations is in devising suitable, safe protocols with associated risk assessments that are also acceptable and sensitive to the views of those participating in the practical work. Although urine is normally sterile, control measures should include each student providing their own sample and not handling or testing other samples. Students should be provided with suitable containers for the collection and transport of urine samples. Students should dispose of samples via a toilet and rinse containers prior to sterilisation. Investigatory work on urine can also be effectively done 'off site', for example by recording the results from diagnostic strips. The results of such investigations should be handled with sensitivity and not attributed to individual students. SSERC can provide advice and recipes for simulated urine samples which provide 'symptoms' analogous to those of specific medical conditions [14] where this is a preferred and more suitable option.

D) Other fluids - tears, sweat etc.

School-based students have successfully carried out investigative and project work on such body fluids. Tears, for example, have been collected and used as a source of lysozymes and sweat has been collected and analysed for salt content. There are no serious grounds, in terms of health and safety, for proscribing such activities so long as an assessment is made of the significant risks and sensible measures are taken to control these.

Note

Parental permission should be sought in the investigation of any human body fluid samples which may be indicative of a medical condition. This would cover urine and blood but is judged unnecessary in the case of saliva. Students should only ever handle their own sample and suitable procedures for safe disposal must be followed.

[13] Although the disposal of sharps boxes and other waste may be unusual for schools, local councils will have these arrangements in place for diabetic patients.

[14] Acknowledgement - based on recipes published by our sister organisation CLEAPSS.

8

APPENDIX 3A

Procedure for school animal(s) being taken home

Advice to teachers if an animal is to be taken home and cared for by a pupil:

1) Complete the protocol for care of the animal(s) and send the protocol and a permission slip home for the parent to read and sign.

2) Make arrangements for suitable transport from school to child's home and back.

3) Make arrangements to cover the costs of extra food, bedding and cleaning materials.

4) Make sure the child knows how to care for the animal(s) including the amount of food and water, when and how to change the bedding, and clean the cage or vivarium etc.

Given below is a suggested format for a permission slip for issue to the parent/guardian of a child wishing to care for a school's animal at home [15].

PERMISSION TO CARE FOR THE SCHOOL ANIMAL(S) AT HOME

To parent/guardian of .....

Please read the attached protocol for the care of the school animal(s) before signing the form below.

Please return to .....

I have read the attached procedures for the care of the school animal(s) and I accept responsibility for the welfare of the animal(s)

which my child will bring home from .....

to .....

I understand that my child has been shown how to care for the animal(s) and understands the feeding and water requirements, and how to clean the cage/vivarium and change the bedding.

I understand that any costs incurred, such as food, bedding, cleaning materials or vet's bills will be reimbursed by the school.

Signed .....

Date .....

APPENDIX 3B

Example of protocol for care of animals at home

Advice to parents if an animal [15] is to be taken home and cared for by the pupil.

1) **How to care for these animals**
Card to be fixed to animal's cage.

2) **Position of cage**
Place the cage in a quiet, warm room.
Do not put in the following places:
- direct sunlight, draughts,
- over radiators, and
- close to other household pets.

3) **Food and water**
- Change the water once a day.
- Feed daily with .....
- Buy extra food from ..... before you run out.
- Fresh greens should be washed and dried before giving to animals.

4) **Cleaning out**
- Clean out the animal's cage as you have been shown, every day.
- Any extra bedding can be obtained from .....

5) **Handling**
Avoid any sudden movements and noise.
Pick the animal up gently and quietly, as you have been shown at school.

6) **Exercise** *(insert statement on here)*.

7) **Health of animals**
Check that the animals are healthy by making sure that they are bright and alert and feeding normally, and have a glossy coat, bright eyes, clean nose and no cuts or sores.

8) **Veterinary surgeon**
If you think the animal is not in good health, contact the vet at .....

Surgery times .....

or the teacher at .....

9) Always wash your hands before and after handling the animal, or cleaning out its cage.

[15] The format of this particular example is one that might be used for a small mammal. It can be adopted for use with other vertebrates.

APPENDIX 4

Examples of animals which may be kept in school

These would include the following: *(The list below is not exhaustive but is included only as a working guide)*	
Mammals	Gerbil (Mongolian) *Meriones sp.* Hamster (Syrian/Golden) *Mesocritus auratus* Mouse (captive albino) *Mus musculus* Rat (captive albino) *Rattus sp.* **N.B.** Rabbits (*Oryctolagus cuniculus*) and Guinea Pigs (*Cavia porcellus*) are not generally recommended for routine use because: 1) adequate space for exercising may not be available. If these animals are exercised outdoors they may come into contact with wild mammals or their faeces which may cause infection. 2) both species can drink large volumes of water over one warm weekend. They can block up drinking bottle nozzles with food particles and bits of bedding and then be without a supply of drinking water.
Birds	Birds should not normally be kept in schools unless the requirements of 2.1 and 2.14 have been satisfied.
Reptiles	Reptiles should not normally be kept in schools unless the requirements of 2.1, 2.12 and 2.14 have been satisfied.
Amphibians	Clawed toad *Xenopus laevus* Axolotl *Ambystoma mexicana* Tiger salamander *Ambystoma sp.* Bullfrog *Rana clamitans*
Fishes	Cold water fishes and tropical fishes normally maintained in aquaria may be kept in schools.
Invertebrates	Protozoa *Amoeba sp.* *Paramecium sp.* Earthworm *Lumbricus terrestris* Snail *Limnaea sp.* Slug *Limax sp.* Giant African Land Snail *Achatina sp.* Brine Shrimps *Artemia salina* Woodlouse *Porcellio sp.* Fruit Fly *Drosophila melanogaster* Flour Beetle *Tribolium sp.* Blowfly Larva *Calliphora sp.* Locust *Locusta migratoria* *Schistocerca gregaria* Stick Insect *Carausius morosus* Cockroach *Periplaneta americana* A variety of common pond animals, obtained by sampling, may be kept in the laboratory or classroom for a short time before the animals are returned to their habitat. Aquatic invertebrate specimens can also be obtained from specialist suppliers.

APPENDIX 5

Use of small mammal traps (including Longworths)

The following procedures take account of guidelines issued by Scottish Natural Heritage for setting live capture small mammal traps (including Longworths).

1) The use of small mammal traps must be supervised by a competent person.

2) Where it is not intended to trap shrews then a shrew escape hole must be drilled in the side of the trap (minimum diameter 13 mm.)

3) Food and nesting material must be provided.

4) Gloves must be used when releasing trapped mammals.

5) Trapped animals must be returned to their natural environment without unnecessary delay.

6) No formal training is required to set live capture small mammal traps. If, however, the traps have been adapted and fitted with a 12 mm hole, their use must be licensed to cover intentional trapping of shrews.

7) Some live capture traps allow for the sensitivity of the treadle to be adjusted. In practice this is not sufficient to prevent shrew capture.

8) When traps are set with the intention of capturing shrews then additional steps need to be taken to minimise shrew mortality. Fuller details on these are available from Scottish Natural Heritage (SNH) [16].

APPENDIX 6

Disposal arrangements

Microbiological materials

For the details of acceptable procedures for the disposal of microbial cultures and similar materials, see the SSERC Code of Practice *Safety in Microbiology.*

Animals and animal tissues

Background

The disposal of animals and animal tissues falls under the *Animal By-Products (Enforcement) (Scotland) Regulations 2011* and their associated guidance note *Controls on Animal By-Products* published by the Scottish Government, Rural and Environment Directorate, Animal Health and Welfare Division. Although these regulations are aimed largely at the food industry they include exception (derogation) for the educational use of animal materials.

Recommendations

Animal material fit for human consumption that has been used for experimentation or dissection is considered an animal by-product. Such material can be disposed of through the normal refuse system to landfill as long as the quantity does not exceed 20 kg in any one week. Schools should keep a record of the nature and quantity of the material and date of disposal. Materials for disposal should be double bagged in opaque polythene. Care should be taken to ensure that the bag is placed within a suitable lidded bin to prevent access to the materials by animals or birds. Small mammals or other vertebrates kept in school that have died of natural causes are also covered by the Animal By-Products Regulations. They may be disposed of to land fill through the normal refuse system in the same way as animal material used for experimentation or dissection. The alternatives are incineration which a veterinary practice can arrange or burial where the Local Authority Environmental Health Service should be consulted.

[16] For more information on the use of Longworth traps:

- J Gurnell and JR Flowerdew. "Live Trapping Small Mammals - A Practical Guide". Available from the Mammal Society.
- Churchfield, S. 1990. "The Natural History of Shrews" Christopher Help, pp 161-166.
- Little, J & J Gurness. "Shrew Captures and Rodent Field Studies" J. Zool., London (1989)218, 329-331

If you require further information or a licence application form for trapping shrews etc., please contact the Licensing Section at Scottish Natural Heritage, 10 Henderson Road, Inverness, IV1 1AU. Telephone 01463 706450, www.snh.gov.uk.

APPENDIX 7

Nervous tissue from cattle, sheep and goats - dissecting eyes

Cattle, sheep and goats may harbour the agent causing transmissible spongiform encephalopathies (TSEs) [17]. Although the risks are small, those parts of slaughtered animals that may harbour the agent may not be supplied or allowed to enter the food chain. These body parts include the brain, spinal chord and eyes of cattle, sheep and goats over 12 months old at slaughter. The supply of these materials is controlled by the *Specified Risk Materials (SRM) Regulations*.

Eyes obtained from cattle, sheep or goats that are 12 months old or less at slaughter are not designated as SRM and may be used and disposed of in the same way as other animal materials. Eyes from other species such as pigs and fish may also be used. Abattoirs can also provide eyes from cattle over 12 months old that are designated SRM. The risks from such materials are low and can readily be controlled by normal laboratory practice. Schools should make a suitable risk assessment. SRM materials must be disposed of by incineration in a place approved for that purpose. A Local Authority Environmental Health Service (or the supplying abattoir) should be able to advise on suitable premises. As part of the SRM regulations the abattoir will have to complete a form which the school will have to countersign. Sufficient time should be allowed to process this form as it has to be completed in advance of the supply of materials.

APPENDIX 8

Selected bibliography

1) *Topics in Safety*, Association for Science Education, 3rd edition, 2001, ISBN 0 86357 316 9. [See in particular Topics 14, 15 and 16. These, in turn, also provide many references to other useful, more detailed, sources.]

2) *Be safe!* Association for Science Education, 4th edition, 2011, ISBN 978 0 86357 426 9.

3) *Safeguards in the School Laboratory*, Association for Science Education, 11th edition, 2006 ISBN 978 0 86357 408 5. [See in particular chapters 13 "Biological Hazards" and 14 "Using Pupils as the Subjects of Investigations".]

4) *Poisonous plants and fungi in Britain, animal and human poisoning*, Marion R. Cooper and Anthony W. Johnson, Stationery Office, 2nd edition, 1998, ISBN 0 11 242981 5.

5) *Safety in microbiology: A code of practice for Scottish schools and colleges*, SSERC, 3rd edition, 2012.

6) *Microbiological Techniques - An Interactive Manual for schools & colleges*, SSERC, 2003. www.sserc.org.uk

[17] Such transmissible spongiform encephalopathies include BSE and nvCJD.

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